Wireless Microphone Interference Study
CMRS & Public Safety in 700 MHz

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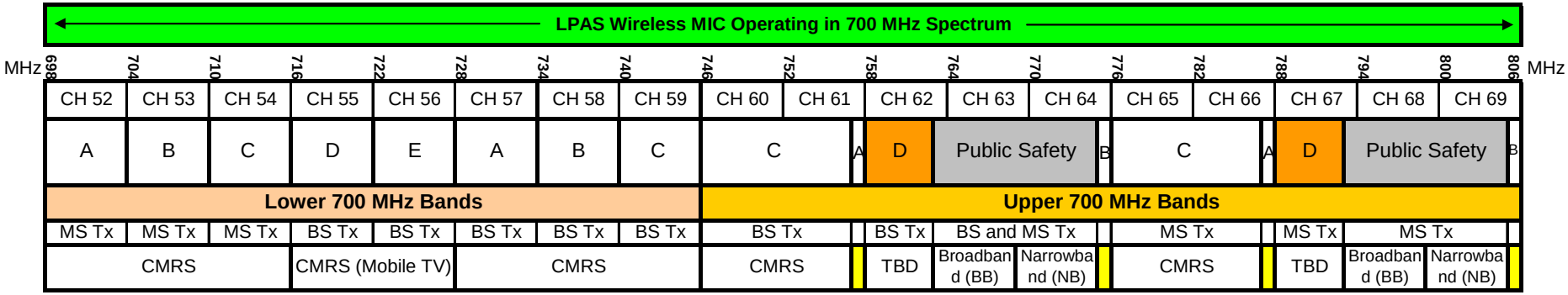
OVERVIEW

- Interference to Wireless Microphone Systems in 700 MHz
  - Study interference from CMRS and Public Safety base stations and mobiles devices
  - Use typical operating parameters to model the expected interference to Wireless Microphone systems operating in the downlink and uplink bands within 700 MHz spectrum
- Interference to CMRS & Public Safety Services
  - Study interference from Wireless Microphones operating in 700 MHz spectrum. Per V-COMM report filed in FCC's LPAS proceeding.
  - Use generalized model to study interference to CMRS and Public Safety base stations and devices operating in 700 MHz.
- Observations and Assessments of Interference
  - Address interference on the downlink and uplink spectrum bands
- Conclusions

700 MHz Spectrum

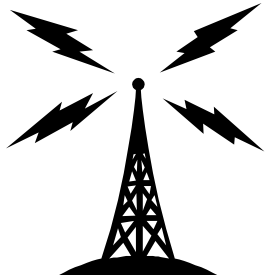
- Wireless microphones (MIC) are authorized pursuant to FCC Part 74 rules for Low Power Auxiliary Stations (LPAS). They operate on a secondary basis in the VHF & UHF TV spectrum, which include the entire 700 MHz spectrum bands. The 700 MHz spectrum chart is provided below. The CMRS & PS downlink and uplink bands are noted as BS Tx and MS Tx, respectively.
  - Interference impacts CMRS and Public Safety (PS) base stations and user devices. Public Safety services include narrowband voice and broadband data services operating in 700 MHz. CMRS services impacted will be 3rd and 4th Generation broadband data, multimedia, and voice services.
  - Interference also impacts Wireless MIC user stations
  - The type of interference addressed in this study is *co-channel* interference.



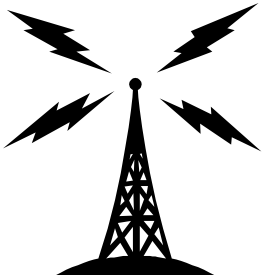
LPAS, CMRS, and PS 700 MHz Operations

LPAS

CMRS



Public Safety



Operating Parameters of Wireless Microphone Systems

- Operating parameters of wireless microphone systems
  - While operating parameters can vary, this analysis is based on a typical system.
  - Transmit power levels vary from 10 mW to 250 mW (50 mW typical). The typical antenna is referenced to a ¼ wave length antenna with gain of 0 dBi (-2 dBd).
  - Wireless microphones use FM modulation with peak deviation of +/- 50 to 75 kHz, and receiver bandwidth of 200 kHz. Equipment thermal noise floor is -109 dBm typically, with 12 dB noise figure and thermal noise of (KTB) -121 dBm/200 kHz.
  - 6 to 10 LPAS units can operate within a single 6 MHz channel in TV spectrum. Some channels will have elevated noise floors due to TV co-channel and adjacent channel signals and other wireless microphone out-of-band signals.
  - Target operating received signal strength is -70 dBm to -80 dBm to overcome standing wave reflections, multi-path fading, inter-modulation, user body and local clutter losses, and for reliable high-quality audio performance. On-channel noise increases the target level.
  - Typical Operating Range is approximately 100 meters (330 ft) for indoor applications. (The FCC Part 74 stated intended range for LPAS is also equal to 100 meters.)
  - Examples of LPAS devices include handheld microphones, belt-pack transmitters with lapel microphones, personal monitoring devices, etc. This study analyzes the handheld case. Other cases can slightly vary results.
- Interference threshold to wireless microphone systems is a 10 dB loss in link budget and operating range. This is used in this interference study.
  - Interference threshold of -95 dBm is used for this interference study.
  - Results in operating range of 32 meters (100 ft), which is about 1/3 the intended range
  - Interference results in loss of operating range, increased dead spots, loss of margin used to mitigate signal reflections, and/or degraded audio quality & performance.

Operating Parameters of CMRS Systems

- CMRS System Parameters
  - Operating parameters for wireless CMRS systems can vary. This study models a hypothetical CMRS system operating in 700 MHz that is representative of a typical system, which is used to determine the impact of interference to wireless microphones operating in 700 MHz.
  - CMRS base station (BTS) and mobile devices (MS) transmit at power levels of 400 Watts ERP and 0.2 Watts (200 mW), respectively. MS antenna gain of 0 dBi (-2 dBd) and body loss of -3 dB is used in this analysis.
  - The CMRS wireless technology used is 3GPP Long Term Evolution (LTE) standard. The downlink uses OFDM, and uplink uses SC-FDMA air-interface standards. The occupied carrier bandwidth for OFDM and SC-FDMA depends on the number of resource blocks used (180 kHz BW per RB).
  - The approximate coverage range of a 700 MHz CMRS base station is assumed to be 2.6 km (1.6 miles) and 1.8 km (1.1 miles) for base station antenna heights of 100 ft and 50 ft AGL, respectively.
- Propagation Model Parameters
  - The Egli propagation model is used -- based on 40 dB log distance propagation loss.
  - Building penetration loss of 10 dB is used.
  - Base station antenna heights of 100 feet and 50 feet AGL are used to model suburban and urban sites. User device antenna height used is 5 feet AGL.

Operating Parameters of Public Safety Systems

- Public Safety (PS) System Parameters
  - Operating parameters for wireless PS systems can vary. This study models a hypothetical PS system operating in 700 MHz that is representative of a typical system, which is used to determine the impact of interference to wireless microphones operating in 700 MHz.
  - PS base station, user vehicle-mounted, and user handheld (portable) equipment transmit at power levels of 200 Watts ERP, 30 and 3 watts, respectively. Portable radio antenna gains of 0 dBi (-2 dBd) and body loss of -3 dB are used, with vehicle-mount antenna gain of 0 dBd with 2 dB cable loss.
  - The Public Safety wireless technology used in this study is the digital Project 25 (P25) Phase 1 standard for narrowband voice, having a nominal bandwidth of 12.5 kHz. (spectral efficiency of 1 user per 12.5 kHz)
  - The approximate coverage range of a 700 MHz PS base station to a portable is assumed to be 4.3 km (2.7 miles) and 3.1 km (1.9 miles) for base station antenna heights of 100 ft and 50 ft AGL, respectively.
- Propagation Model Parameters
  - The Egli propagation model is used -- based on 40 dB log distance propagation loss.
  - Building penetration loss of 10 dB is used.
  - Base station antenna heights of 100 feet and 50 feet AGL are used to model suburban and urban sites. User device antenna height used is 5 feet AGL.

Range of Interference to Wireless Microphone Systems in Downlink & Uplink 700 MHz bands

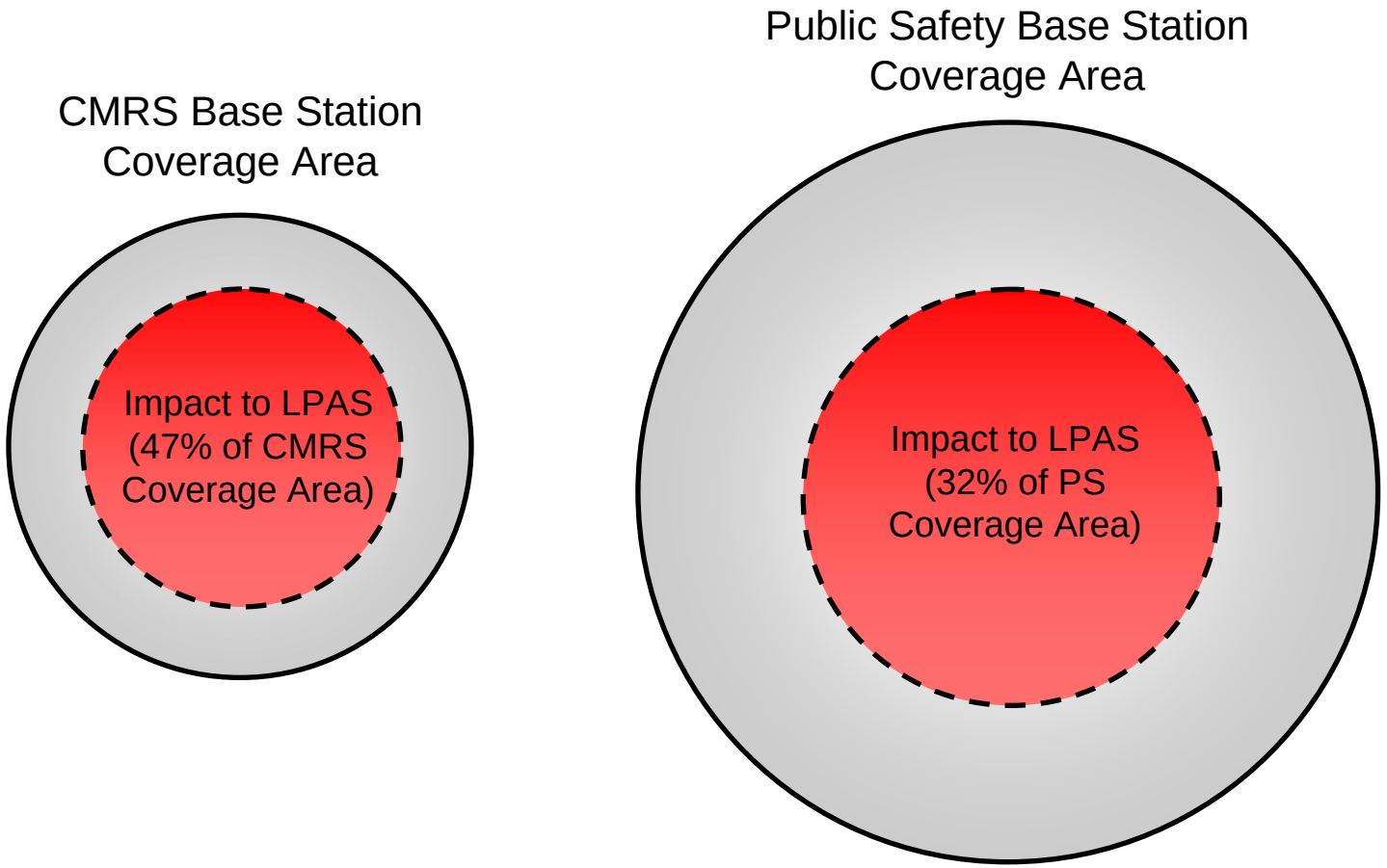
- Range of co-channel interference from CMRS and Public Safety base stations (BTS) and mobile stations (MS) to wireless microphone systems is given below. The BTS and MS cases below represent the downlink and uplink spectrum bands, respectively.

CMRS Interference	Suburban BTS (100 ft AGL)	Urban BTS (50 ft AGL)	CMRS MS
Range of Impact to LPAS MIC	1.8 km (1.1 mi)	1.3 km (0.8 mi)	79 m (260 ft)

Public Safety (PS) Interference	Suburban BTS (100 ft AGL)	Urban BTS (50 ft AGL)	PS MS (Portable)	PS MS (Vehicular)
Range of Impact to LPAS MIC	2.4 km (1.5 mi)	1.7 km (1.1 mi)	144 m (471 ft)	303 m (995 ft)

Area of Interference to Wireless Microphone Systems in Downlink 700 MHz bands

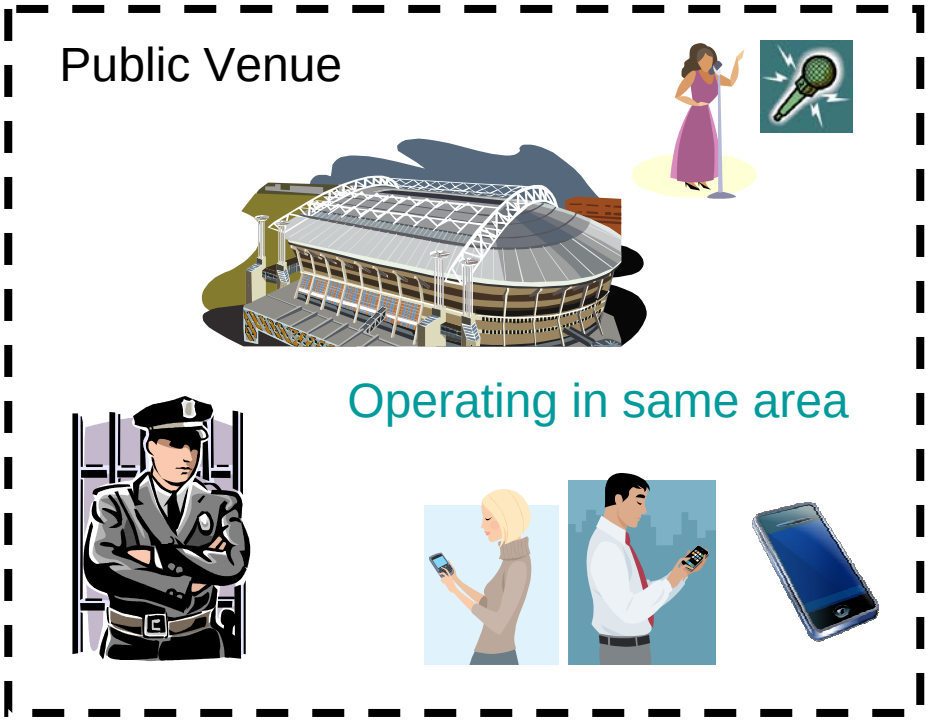
- The interference impact area to wireless microphone systems is 47% and 32% of the CMRS and Public Safety base stations coverage areas, respectively, when operating in the CMRS & Public Safety ***downlink*** spectrum bands.



Interference to Wireless Microphone Systems in Downlink & Uplink 700 MHz bands

- Significant areas of interference will occur to wireless microphone systems operating on the ***downlink*** spectrum of CMRS and Public Safety 700 MHz systems, representing approximately 1/2 to 1/3 of the base station coverage areas.
  - Shaded areas within the circles represents the LPAS interference areas, which are concentrated near the center. Outer parts of the base station coverage area would not have interference.
  - Wireless microphone systems may operate on downlink spectrum in outer parts of BTS coverage areas.
- The range of interference to wireless microphone systems operating on the ***uplink*** spectrum from CMRS & Public Safety mobile devices will occur within the venue operating the wireless microphone system and from CMRS & PS devices used nearby.
  - Range from CMRS devices is 79 meters.
  - Range from PS vehicles and portables is 303 and 144 meters.
  - Interference on uplink spectrum bands will be intermittent, based on proximity of nearby mobile users.

Interference to Wireless Microphone Systems
in Uplink 700 MHz bands



- Interference impact to LPAS on CMRS & PS ***uplink*** spectrum bands
  - Generally limited to areas within and nearby venues operating wireless microphones.
  - The exception would be close to CMRS base stations when CMRS devices are powered to very low levels. In these cases, the CMRS devices can transmit at power levels below -20 dBm (10 microwatts), and the interference range is limited to within the venue and <10 m.

Observations and Assessments of Interference to Wireless Microphones operating in 700 MHz

- Many wireless microphone systems will experience significant interference from CMRS & Public Safety services operating in 700 MHz
- Impact of interference will result in degraded range and performance to the wireless microphone system
  - Poor performance; bad audio quality
  - Poor range and/or dead spots
- Some wireless microphone systems operating further away from CMRS & PS base stations on ***downlink*** 700 MHz spectrum bands and with shorter range requirements can continue to operate without interference
  - However, these wireless microphones can still interfere with CMRS & Public Safety mobile devices.

Observations and Assessments of Interference to Wireless Microphones operating in 700 MHz

- Wireless microphone systems operating on ***uplink*** 700 MHz spectrum bands can experience unpredictable, intermittent interference from *mobile* CMRS & Public Safety vehicular/portable user devices.
  - This type of “mobile”, nomadic interference will not be easily detected or identifiable, and can frustrate the Wireless Microphone users.
  - For example a wireless microphone system that is performing at peak performance during pre-system set ups for a major concert or event, may experience unexpected and significant interference from a mobile device operating in 700 MHz *during* the event or show (e.g., someone in the audience using a data device).
  - This type of “mobile” intermittent interference is different than the type of interference wireless microphone users are used to dealing with in UHF spectrum, which are “fixed” TV broadcast transmissions operating at consistent levels from fixed locations.

Interference to 700 MHz CMRS & Public Safety Systems

- V-COMM studied the interference from wireless microphones to CMRS & Public Safety systems operating in 700 MHz.
  - V-COMM's Report was filed in the FCC WT Docket No. 08-166 and 08-167 on October 1, 2008.
  - Typical operating parameters for CMRS & Public Safety systems and wireless microphone systems were utilized in the interference study.
  - The range of interference from wireless microphones to CMRS and Public Safety base stations and devices are provided in the table below, with and without 10 dB of clutter loss (i.e. typical loss of 1 wall partition).

MIC Transmit Power (mW)	BTS with 10 dB Clutter Loss (km)	BTS with No Clutter Loss (km)	Devices with 10 dB Clutter Loss (m)	Devices with No Clutter Loss (m)
250	1.8	3.3	220	400
100	1.4	2.6	175	318
50	1.2	2.2	147	267
10	0.8	1.5	98	179

Interference to 700 MHz CMRS & Public Safety Systems

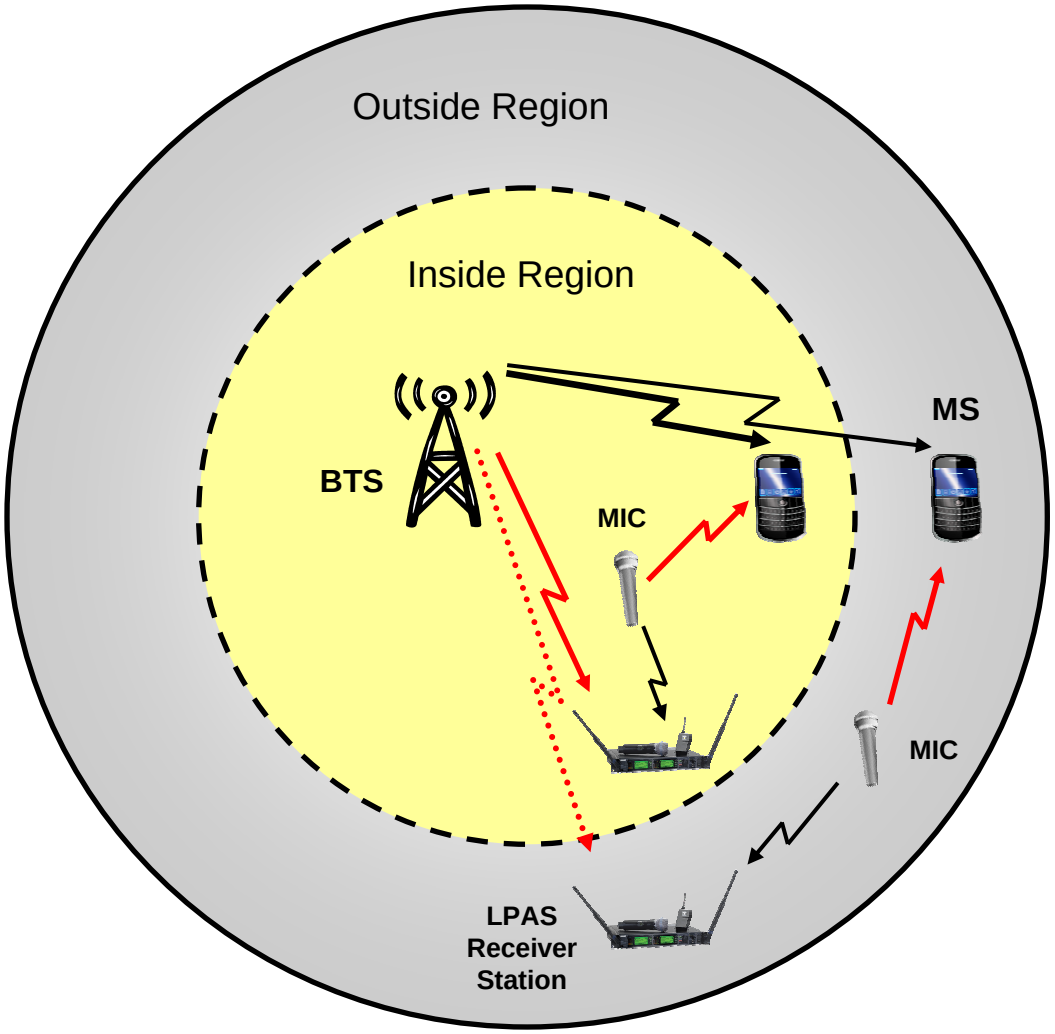
- Interference Assessment to CMRS and Public Safety services operating in 700 MHz spectrum
  - Significant interference will occur to CMRS & Public Safety operating in 700 MHz spectrum, particularly on the *uplink* spectrum bands.
  - Range of interference to CMRS and Public Safety is extensive
    - Range of uplink interference to BTS is 0.8 to 3.3 km.
    - Range of downlink interference to mobile devices is 98 to 400 meters.
  - In some cases, results in detrimental impact to licensed, primary operations
    - CMRS and PS 700 MHz system operation & quality jeopardized
    - For Public Safety, potential *life threatening* impact
    - Outdoor event locations are represented by the case without clutter losses. These include outdoor sporting arenas, concerts, shows, parades, political conventions, etc., which impact larger areas than indoor microphone uses.
- Some events and venues can operate with hundreds of microphones simultaneously (i.e. Major Shows, Sporting Events, Mega-Churches, etc.)
- Due to the above instances of harmful interference, wireless microphones, CMRS & Public Safety services are not compatible and cannot co-exist in 700 MHz spectrum; they both can suffer harmful interference if they continue to operate in the band.

Interference Between CMRS & Public Safety vs. Wireless Microphones

- Operation of wireless microphones in the same spectrum as CMRS and Public Safety will result in significant harmful interference to all parties.
  - In most cases, the interference will NOT be mutual. It will impact one user or the other user (not both at the same time). In each case, it will impact either the Wireless Microphone system or the CMRS/PS system, but not both systems at the same time. The interference depends on proximity between the systems and uplink/downlink spectrum band used.
  - Since the interference is not mutual, the wireless microphone users will not have an incentive to resolve interference caused to CMRS and Public Safety systems.

Interference Between CMRS & Public Safety vs. Wireless Microphones

Downlink Spectrum Case -- LPAS operating on CMRS/PS ***downlink*** band



Outside Region (Away from BTS)

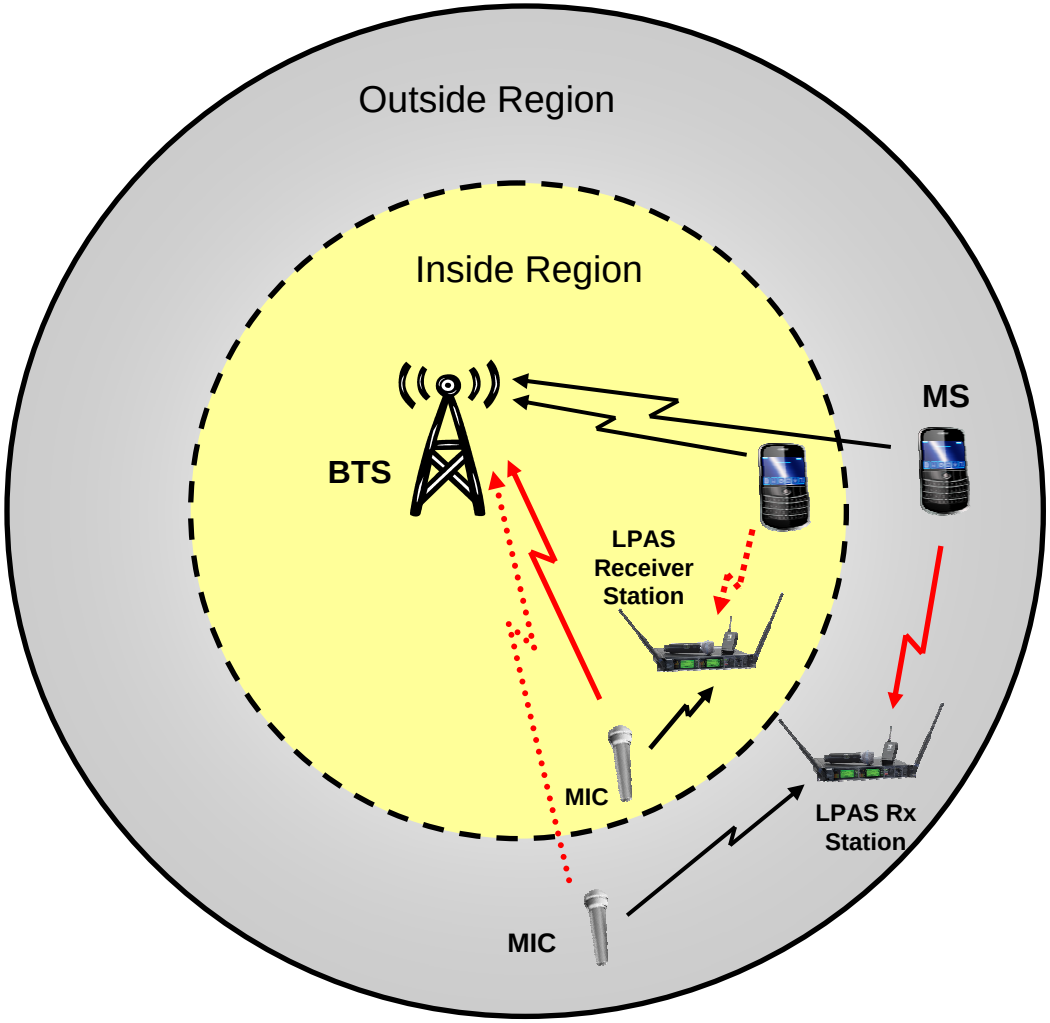
- CMRS & PS devices receive lower *desired* signals from serving BTS, and are most vulnerable to LPAS interference in these regions.
- Results in significant interference to CMRS & PS devices.
- LPAS users receive weakest interference from CMRS & PS BTS. Thus, in these regions LPAS users can operate without any interference.

Inside Region (Near BTS)

- LPAS users experience strongest interference from CMRS & PS BTS.
  - Some LPAS users can tune to other channels to avoid the interference
- CMRS & PS devices receive stronger desired signals, which can mitigate LPAS interference in some cases.

Interference Between CMRS & Public Safety vs. Wireless Microphones

Uplink Spectrum Case -- LPAS operating on CMRS/PS ***uplink*** band



Outside Region (Away from BTS)

- LPAS users receive strong interference from nearby CMRS & PS devices.
  - Some LPAS users can tune to other channels to avoid the interference
- CMRS & PS BTS receive less interference from LPAS users that are farther away from BTS.

Inside Region (Near BTS)

- CMRS & PS BTS experience strongest interference from LPAS users that are closer to BTS.
- Results in significant interference to CMRS & PS BTS.
- LPAS users receive weakest interference from CMRS devices, which are powered back when they are near their serving BTS.
- Thus, in these regions LPAS users can operate without interference from CMRS devices.

Summary of Interference between CMRS & Public Safety vs. Wireless Microphones in Downlink & Uplink 700 MHz bands

- Wireless microphone users receive the strongest interference when they are:
  - Operating in *downlink* band and closer to CMRS/PS base stations
  - Operating in *uplink* band and farther away from CMRS/PS base stations
- When this occurs, the wireless microphone system may re-tune (switch) to the other band used by either the CMRS or PS system
  - This eliminates the interference to the wireless microphone system
  - This results in the causing the strongest interference to CMRS & Public Safety systems
- Wireless microphones cause the strongest interference to CMRS and Public Safety systems (base stations or mobile devices) when they are:
  - Operating in *uplink* band and closer to CMRS/PS base stations
  - Operating in *downlink* band & farther away from CMRS/PS base stations
  - In these cases, wireless microphones can operate interference-free.

Conclusions

- Operation of wireless microphones in the same spectrum as CMRS and Public Safety will result in significant harmful interference to all parties.
  - In most cases, the interference will NOT be mutual. It will impact one user or the other user (not both at the same time). It will impact either the Wireless Microphone system or the CMRS/PS system, not both at the same time. The interference depends on proximity between the systems and uplink/downlink spectrum band used.
  - Since the interference is not mutual, there is no incentive to resolve the interference caused to the other party.
  - Both types of systems operate with sufficient power levels to cause interference to each other; they cannot co-exist on a co-channel basis in the 700 MHz spectrum.
- Wireless microphone systems must be cleared from 700 MHz to prevent interference to CMRS, Public Safety, and microphones users

APPENDIX

Link Budgets of Interference Study

V-COMM Background & Information

Link Budget of Wireless Microphone System & Interference Threshold

Description	Link Budget	Units	Notes
LPAS Transmit Output Power Level (mW)	50	milliwatts	LPAS typical output power is 50 mW (average case).
LPAS Transmit Output Power Level (dBm)	17.0	dBm	
LPAS User Body Loss (handheld MIC)	-3	dB	Handheld case is 0 to -3 dB loss (typ). Beltpack unit 0 to -10 dB loss.
LPAS Transmit Antenna Gain	-2	dBd	1/4 wavelength antenna (typical)
LPAS Receive Antenna Gain	-2	dBd	1/4 wavelength antenna (typical)
LPAS Receiver Sensitivity (nominal squelch, no fading)	-94.0	dBm	As per test results for 5 LPAS units. Rx Sens = -94 dBm on average for the nominal (medium) squelch setting. At the lowest squelch setting it was -97 dBm on average, for 30 dB SINAD.
LPAS Operating & Fade Margin (for high reliability)	14.0	dB	For high reliabiliy and quality, to overcome multi-path fading, standing wave reflections, intermodulation, etc. in the environment.
LPAS Minimum RSSI (with fading, no environmental noise)	-80.0	dBm	
Environmental noise level elevated above equipment noise floor (indoor case)	4.0	dB	As per measurements in market. Observed noise floor elevated indoors by 4 dB (typical case) above equipment noise floor (may be due to adj. & distant co-channel analog & DTV signals in 700 MHz).
Target Signal Strength @ LPAS Rcvr to overcome fading and environment noise	-76.0	dBm	
LPAS Link Budget Path Loss (dipole antenna ref.)	86.0	dB	
Propagation Range (distance in meters) of LPAS System	100	meters	Indoor propagation at 30dB log distance at frequency of 776 MHz , includes indoor clutter losses (internal walls, structures, people loss, etc.)

Thermal Noise Floor (KTB) for 200 kHz nominal bandwidth	-121.0	dBm	
LPAS Receiver Noise Figure (typ.)	12.0	dB	Computed from equipment noise floor subtract thermal noise floor.
LPAS Receiver Equipment Noise Floor	-109.0	dBm	As per measurements on 5 LPAS units (average case).
Carrier-to-Noise ratio (C/N) for non-fading signals	15.0	dB	C/N for non-fading signals at nominal (medium) squelch setting. Non-fading C/N at minimum (lowest) squelch setting is 12 dB in the lab for 30 dB SINAD.
Environmental noise level elevated above equipment noise floor (indoor case)	4.0	dB	As measured, noise level in market -107 dBm/200kHz (typical). Added to Noise Floor -109 dBm, yeilds -105 dBm noise level (4 dB above thermal noise).
LPAS Receiver Operating Noise Level	-105.0	dBm	Operating noise level 4 dB above equipment noise floor, as measured for typical indoor systems in 700 MHz spectrum.

Interference Threshold (Reduction in LPAS System Operating Link Budget)	10.0	dB	Reduces LPAS Operating Link Budget Path Loss (i.e. from 86 dB to 76 dB).
Reduction of LPAS Operating System Range (%)	68%	%	Interference threshold reduces LPAS operating range by 68%
New LPAS Operating Range (meters)	31.7	meters	Interference threshold reduces LPAS operating range to 32 meters (104 ft)
Interference Threshold for interference analysis	-95.0	dBm	Increases LPAS Receiver Operating Noise level by 10 dB (-105 to -95 dBm). This threshold is refereneced AWGN type interference.

Link Budget of Interference from CMRS BTS to LPAS Receiver

Description	CMRS Base Station	Units	Notes
CMRS Base Station Transmit Power (ERP in Watts)	400	Watts	BTS output power of 40 Watts, 2 dB coaxial cable loss, 12 dBd antenna gain (3 sector panel antenna)
CMRS Base Station Transmit Power (ERP in dBm)	56.0	dBm	
Power reduction for 200 kHz bandwidth LPAS Rcvr	-16.5	dB	Convert occupied bandwith signal of 9 MHz for LTE OFDM downlink carrier to 200 kHz BW.
Building Penetration Loss	-10	dB	
LPAS Receive Station Antenna Gain	-2	dBd	1/4 wavelength antenna (typical)
Interference Threshold for LPAS System	-95.0	dBm	LPAS Interference threshold. Interference from LTE signals exhibit similar impact as AWGN source.
Required Path Loss to reach Interference Threshold	122.5	dB	

Range of Interference to LPAS System from CMRS BTS (Suburban BTS, 100 ft AGL)	1.78	km	Use Egli propagation (40 dB Log distance) loss at 776 MHz, with BTS antenna height 100 ft, LPAS 5 ft.
Range of Interference to LPAS System from CMRS BTS (Suburban BTS, 100 ft AGL)	1.11	miles	Use Egli propagation (40 dB Log distance) loss at 776 MHz, with BTS antenna height 100 ft, LPAS 5 ft.

Range of Interference to LPAS System from CMRS BTS (Urban BTS, 50 ft AGL)	1.26	km	Use Egli propagation (40 dB Log distance) loss at 776 MHz, with BTS antenna height 50 ft, LPAS 5 ft.
Range of Interference to LPAS System from CMRS BTS (Urban BTS, 50 ft AGL)	0.78	miles	Use Egli propagation (40 dB Log distance) loss at 776 MHz, with BTS antenna height 50 ft, LPAS 5 ft.

Link Budget of Interference from CMRS Mobile Device to LPAS Receiver

Description	CMRS Mobile Device	Units	Notes
CMRS Mobile Device Transmit Power (ERP in mW)	126	mW	Nominal user device output power 200 mW, with -2 dBd antenna gain.
CMRS Mobile Device Transmit Power (ERP in dBm)	21.0	dBm	Nominal output power +23 dBm, -2 dBd antenna gain.
Power reduction for 200 kHz bandwidth LPAS Rcvr	-6.5	dB	Convert occupied bandwith of 0.9 MHz for case of LTE SC-FDMA uplink carrier using 5 resource blocks.
CMRS Mobile Device, User Body Loss	-3	dB	
Building Penetration Loss	-10	dB	
LPAS Receive Station Antenna Gain	-2	dBd	1/4 wavelength antenna (typical)
Interference Threshold for LPAS System	-95.0	dBm	LPAS Interference threshold. Interference from LTE signals exhibit similar impact as AWGN source.
Required Path Loss to reach Interference Threshold	94.5	dB	

Range of Interference to LPAS System from CMRS Mobile Device	79	meters	Use Egli propagation (40 dB Log distance) loss at 776 MHz, with Mobile Device antenna height & LPAS 5 ft.
Range of Interference to LPAS System from CMRS Mobile Device	260	feet	Use Egli propagation (40 dB Log distance) loss at 776 MHz, with Mobile Device antenna height & LPAS 5 ft.

Link Budget of Interference from Public Safety BTS to LPAS Receiver

Description	Public Safety Base Station	Units	Notes
Public Safety BTS Transmit Power (ERP in Watts)	200	Watts	BTS output power of 100 Watts, 2 dB coaxial cable loss, 9 dBd antenna gain omni, 4 dB combiner losses
Public Safety BTS Transmit Power (ERP in dBm)	53.0	dBm	
P25 Phase 1 (12.5 kHz) Interference reduction for LPAS Receiver	-8.0	dB	As measured for P25 signal. LPAS receiver 8 dB less sensitive to P25 interference vs. AWGN dBm/200kHz.
Building Penetration Loss	-10	dB	
LPAS Receive Station Antenna Gain	-2	dBd	1/4 wavelength antenna (typical)
Interference Threshold for LPAS System	-95.0	dBm	LPAS Interference threshold (AWGN reference)
Required Path Loss to reach Interference Threshold	128.0	dB	

Range of Interference to LPAS System from Public Safety BTS (Suburban BTS, 100 ft AGL)	2.446	km	Use Egli propagation (40 dB Log distance) loss at 776 MHz, with BTS antenna height 100 ft, LPAS 5 ft.
Range of Interference to LPAS System from Public Safety BTS (Suburban BTS, 100 ft AGL)	1.52	miles	Use Egli propagation (40 dB Log distance) loss at 776 MHz, with BTS antenna height 100 ft, LPAS 5 ft.

Range of Interference to LPAS System from Public Safety BTS (Urban BTS, 50 ft AGL)	1.73	km	Use Egli propagation (40 dB Log distance) loss at 776 MHz, with BTS antenna height 50 ft, LPAS 5 ft.
Range of Interference to LPAS System from Public Safety BTS (Urban BTS, 50 ft AGL)	1.08	miles	Use Egli propagation (40 dB Log distance) loss at 776 MHz, with BTS antenna height 50 ft, LPAS 5 ft.

Link Budget of Interference from PS Mobile Devices to LPAS Receiver

Description	Public Safety Portable Unit @ 3 Watts	Public Safety Vehicle Unit @ 30 Watts	Units	Notes
Public Safety Mobile Device Tx Power (ERP in Watts)	1.9	18.9	Watts	PS Portable 3 Watts with -2 dBd antenna. PS Vehicle 30 Watts with 0 dBd antenna and 2 dB cable loss.
Public Safety Mobile Device Tx Power (ERP in dBm)	32.8	42.8	dBm	Nominal output power +23 dBm, -2 dBd antenna gain.
P25 Phase 1 (12.5 kHz) Interference reduction for LPAS Receiver	-8.0	-8.0	dB	As measured for P25 signal. LPAS receiver 8 dB less sensitive to P25 interference vs. AWGN dBm/200kHz.
Public Safety Mobile Device, User Body Loss	-3	0	dB	
Building Penetration Loss	-10	-10	dB	
LPAS Receive Station Antenna Gain	-2	-2	dBd	1/4 wavelength antenna (typical)
Interference Threshold for LPAS System	-95.0	-95.0	dBm	LPAS Interference threshold (AWGN reference)
Required Path Loss to reach Interference Threshold	104.8	117.8	dB	

Range of Interference to LPAS System from Public Safety Mobile Device	144	303	meters	Use Egli propagation (40 dB Log distance) loss at 776 MHz, with Mobile Device antenna height & LPAS 5 ft.
Range of Interference to LPAS System from Public Safety Mobile Device	471	995	feet	Use Egli propagation (40 dB Log distance) loss at 776 MHz, with Mobile Device antenna height & LPAS 5 ft.

V-COMM is a leading provider of quality engineering and engineering consulting services to the worldwide wireless telecommunications industry with offices in Cranbury, NJ and Blue Bell, PA. V-COMM's engineering staff is experienced in Cellular, Personal Communications Services (PCS), Enhanced Specialized Mobile Radio (ESMR), Paging, Wireless Broadband Data, 2-Way radio, Microwave and Broadcast Mobile TV networks. We have provided our expertise to wireless operators in engineering, system design, implementation, performance, optimization, and evaluation of new wireless technologies.

We have extensive experience in analyzing interference in various spectrum bands including Cellular, SMR, PCS, AWS, Air-to-ground, Public Safety, and 700 MHz spectrum. We have engineering experience in all commercial wireless technologies, including HSPA, UMTS, EVDO, CDMA, GSM, MediaFLO, DVB-H and Analog technologies, and Public Safety wireless technologies including analog and digital Project 25, EDACS & Opensky, and many trunking and conventional radio networks. Further, V-COMM was selected by the FCC & Department of Justice to provide expert analysis and testimony in the Nextwave and Pocket Communications Bankruptcy cases.

For additional information, visit V-COMM's web site at www.vcomm-eng.com.